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13. ABSTRACT: Photoinduced magnetism (PIM) studies were successfully extended to the class of organic-based high T_c magnetic semiconductors based on $V[TCNE]_2$, with PIM discovered in the chemical vapor deposition (CVD) prepared films to nearly 150 K. A previously unknown phenomenon, photoinduced diamagnetism (reversible decrease in the magnetization) was revealed in these materials. We developed a powerful new experimental method to studies PIM, PhotoInduced FerroMagnetic Resonance (PIFMR). PIFMR determined that the photoinduced decrease of the magnetization of $V[TCNE]_2$ was due to a photoinduced reduction in the permeability of $V[TCNE]_2$ and did not affect the saturation magnetization of the $V[TCNE]_2$. Thus photomodulation of the permeability of antenna materials incorporating $V[TCNE]_2$ may be possible. $V_xM_{1-x}[TCNE]_2$ $z(CH_2Cl_2)$ samples, with M = Co, Fe were prepared in solution of CH_2Cl_2 to further control the permeability and PIM. Modification of the CVD reactor to prepare films with three components (e.g., $V(CO)_6$, $Co_2(CO)_8$, and TCNE are being made. These modifications must accommodate the different vapor pressures and reactivity rates for the different components. When these modifications are complete this will be a powerful means to prepare films for future PIM development as well as for preparation of three component films for incorporation in multilayers for controlled permeability.

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Executive Summary:

Progress and Accomplishments
During the Period of AFOSR Grant No. F49620-03-1-0175

The support of AFOSR (since 1 December 1999) has been instrumental in the exciting and rapid progress in our investigations of the phenomenon of photoinduced magnetism. Our research has resulted in major publications, invited and contributed talks. It has received notable recognition from the scientific community, as well as attention of a wider audience, reflected in numerous popular articles featuring our work. A list of publications, presentations, and articles in popular press that have resulted from the studies under the AFOSR grant is presented below. The materials presented here represent the advances made in the grant period, i.e., March 1 2003 through February 28, 2006. The project has been a combination of synthesis, characterization, and photoinduced magnetism studies.

Remarkable progress was achieved in our investigations of photoinduced magnetism (PIM) in several families of molecule-based magnets during the first three years of AFOSR support (1999-2002). These include development of a new experimental method to studies PIM (the first report of photoinduced ac susceptibility (PIACCHI)), report of the first system with coexisting photomagnetic and spin glass behavior, proposal of a new mechanism for photomagnetic effects in Prussian blue magnets, and, discovery of the first organic-based light-modulated magnet. We determined a highly unconventional type of magnetic ordering and proposed the first model for PIM effects that accounts for the observed cluster glass behavior. Our discovery of PIM in $Mn[TCNE]_2 \cdot x(CH_2Cl_2)$ (TCNE = tetracyanoethylene) resulted in dramatically higher PIM operating temperature (~ 80 K) than the one for the initially studied Prussian Blue magnets (~20 K).

During the second three-year funding period (2003-2005), PIM studies were successfully extended to the class of organic-based high T_c magnetic semiconductors based on $V[TCNE]_2$, with PIM present in the chemical vapor deposition (CVD) prepared films to nearly 150 K. A previously unknown phenomenon, photoinduced diamagnetism was discovered in these materials. That is, the PIM resulted in a reversible decrease in the magnetization of these materials. We developed of a powerful new experimental method to studies PIM in $V[TCNE]_2$ and related materials, PhotoInduced FerroMagnetic Resonance (PIFMR). PIFMR demonstrated that the photoinduced decrease of the magnetization of $V[TCNE]_2$ was due to a photoinduced reduction in the permeability of $V[TCNE]_2$ and did not affect the saturation magnetization of the $V[TCNE]_2$. This opens the possibility of using the PIM phenomenon to photomodulate the permeability of antenna materials incorporating $V[TCNE]_2$. During this second three year funding period studies were carried out to use chemistry to further control the permeability and PIM of the $V[TCNE]_2$ family. $V_xM_{1-x}[TCNE]_2\ z(CH_2Cl_2)$ samples, with M = Co, Fe were prepared in solution of CH_2Cl_2. Similar to solution prepared samples of the $V[TCNE]_2$ PIM was not observed in these samples. Work has begun in modification of the CVD reactor to prepare films with three component (e.g., $V(CO)_6$, $Co_2(CO)_8$, and TCNE. These modifications must accommodate the different vapor pressures and reactivity rates for the different components. When these modifications are complete this will be a powerful means to prepare films for PIM as well as for preparation of three component films for incorporation in multilayers. Selected detailed results for study of PIM of $V[TCNE]_2$ CVD prepared films are shown below.

The experiments during the second three year funding period included the first use of ac susceptometry to probe light induced changes in spin dynamics in $RbMn[Fe(CN)_6]$ where light can be used to switch from a diamagnetic state to a ferromagnetic state. Selected results are shown below. In the past year we also successfully discovered and characterized the PIM in a class of material, the pentacyano Prussian Blue analogue $Cr[Cr(CN)_5NO]$, with $T_c = 80$ K and positive PIM present to ~ 50 K. Results are illustrated below for this new system.

We also carried out extensive syntheses and chemical, magnetic, and PIM characterization of several new classes of materials that, because of their chemical and crystal structures were expected to possibly show PIM. The materials include $V_xCo_{1-x}[TCNE]_2$, x = 0.25, 0.5, 0.75, $Mn[TCNQ]_2$, $Ni[TCNQ]_2$, $Mn[TCNE]_2$ from MnI_2, and $[Ru^{II/III}{}_2(O_2CCH_3)_4]_3[M^{III}(CN)_6]$, M = Co, Fe, Ni, Cr in H_2O, and M = Co, Fe, Cr in CH_3CN. Unfortunately no or only weak PIM was determined in these materials. Further studies are in progress to determine if the PIM is truly absent or is suppressed because of the fabrication method used. Detail data were provided in an earlier powerpoint report provided in August 2005 to Dr. Charles Lee, and reproduced in Appendix A.

A new room temperature organic-based magnet was prepared in solution using $V(CO)_6$ and tetracyanobenzene (TCNB). $V[TCNB]_x$ forms powders with magnetic order up to 325K, only the third molecule-based magnet with magnetic ordering above room temperature, see below, and the PIM will be the subject of future studies.

Selected recent results (more extensive results were sent as powerpoint files to Dr. Charles Lee in August 2005 and are reproduced in Appendix A).

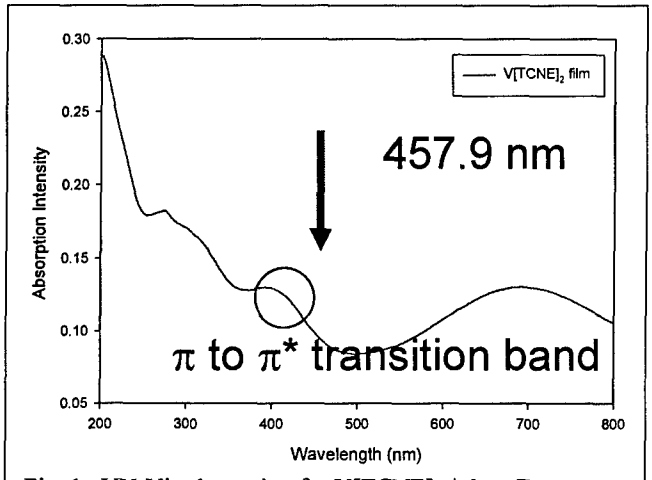

Fig. 1. UV-Vis absorption for $V[TCNE]_2$ φιλμ. Τηε π – π* absorption is labeled.

photoinduced changes in the hysteresis loop. Fig. 3. The PIM in $V[TCNE]_2$ differs from that of $Mn[TCNE]_2$. For the $Mn[TCNE]_2$, the PIM is in the form of a light induced increase in the magnetic response of the $Mn[TCNE]_2$ powder. For $V[TCNE]_2$, the PIM is in the form of a light induced is decrease in the magnetic response of the $V[TCNE]_2$ film.

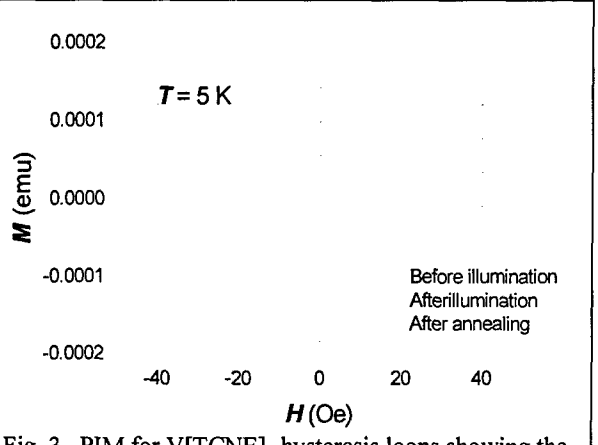

Fig. 3. PIM for $V[TCNE]_2$ hysteresis loops showing the possibility of using PIM to control initial permeability.

Initial studies of the photoinduced magnetism (PIM) of powder samples of the room temperature magnet $V[TCNE]_2$ made from CH_2Cl_2 solution (and incorporating solvent) did not produce observable PIM. We extended the studies to PIM for chemical vapor deposition (CVD) prepared solvent-free films, achieving PIM success. The CVD films prepared are magnetic to above room temperature. Excitation with 458 nm light the π – π* transition of TCNE (Fig. 1) gives a reversible ~ 15% modulation of the magnetization at low temperature, that persists to ~150 K, Fig. 2, together with reversible

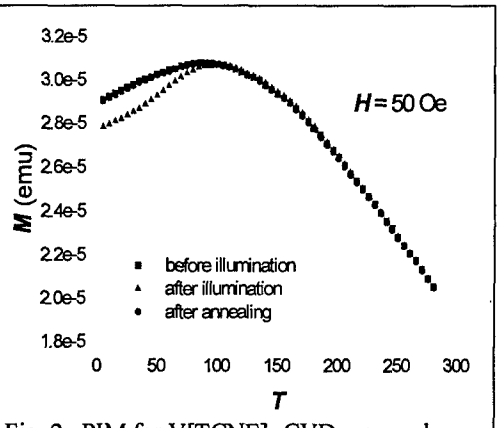

Fig. 2. PIM for $V[TCNE]_2$ CVD prepared films. The blue curve shows the reduction by ~15% of the magnetization upon excitation with 458 nm light. The red curve shows that after heating to above 200K the original magnetization is regained.

Extension of these PIM studies to solution made powders incorporating Co and other ions were not successful at increasing the temperature for the PIM. (We note that the solution prepared powder samples of $V[TCNE]_2$ also did not show PIM, thus there is an important role for the preparation technique in achieving PIM.)

We are in the process of modifying our CVD chambers to allow more complex compositions to be prepared by this method. The potential impact of these results extends beyond light control of magnetism of $V[TCNE]_2$ films. In parallel studies we recently have been successful in showing that $V[TCNE]_2$ is a fully spin polarized magnetic semiconductor that may be incorporated as a spin analyzer layer in spin valve structures. Our PIM results support the possibility of, for the first time, using light to control spintronics. Further, our earlier studies showed the potential of using $V[TCNE]_2$ pellets to guide magnetic fields. The PIM effect in $V[TCNE]_2$ films may enable using light to control the behavior of antennas incorporating $V[TCNE]_2$ as a magnetic component.

We have extended our study of PIM of $V[TCNE]_2$ CVD films to the study of the effect of light on the X-band ferromagnetic resonance, FMR, Fig. 4 We find that excitation into the π – π* absorption results in an increase in the EPR linewidth and a decrease in the resonance field. At the same time there is no significant change in the

integrated EPR intensity, Fig. 5. This demonstrates that the PIM results as shown in Fig. 2 are a result of

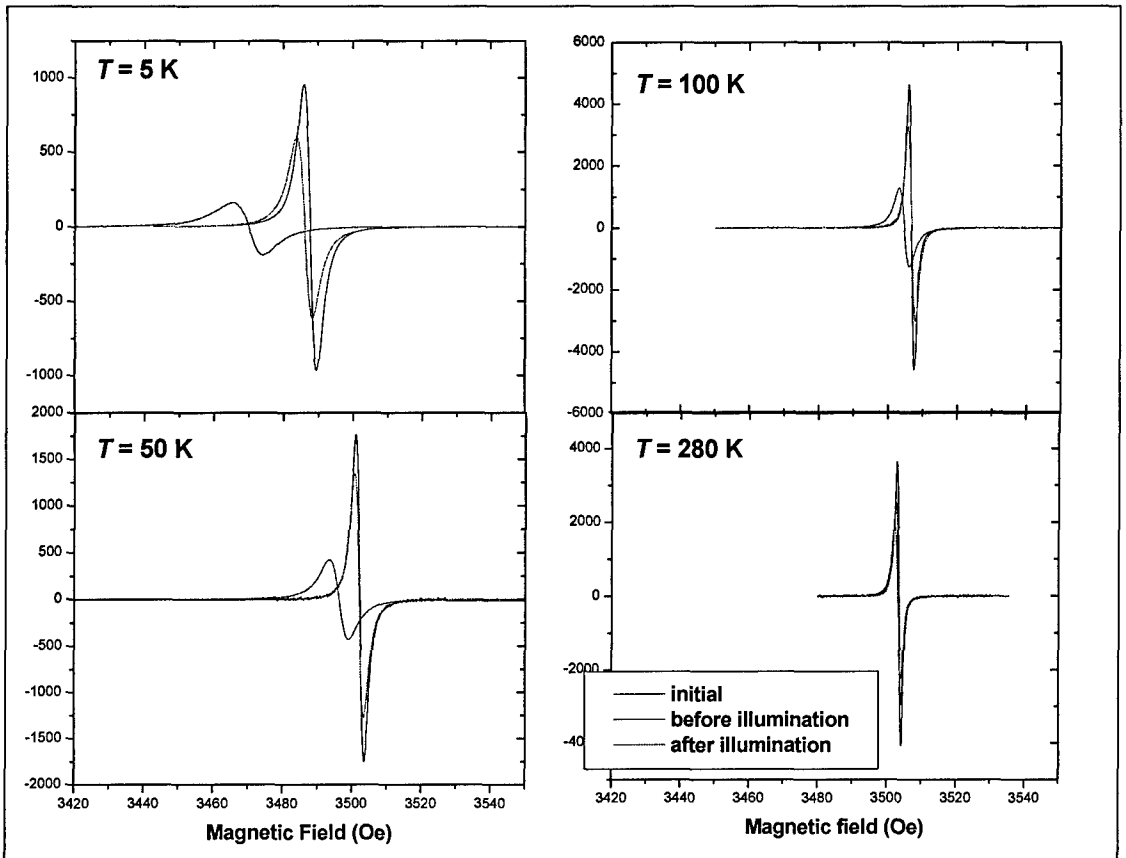

Fig.4. Photoinduced ferromagnetic resonance (PIFMR) of $V[TCNE]_2$ CVD films.

photoinduced changes in permeability and not changes in the saturation magnetization. This supports the potential utility of PIM in $V[TCNE]_2$ and similar materials for optical control of antenna function.

We have extended our studies of PIM in the $M[TCNE]_2$ family to solution prepared powders of $V_xCo_{1-x}[TCNE]_2$ $z(CH_2Cl_2)$, which enable us to control coercivity of the material. The solution made $Co[TCNE]_2{\cdot}z(CH_2Cl_2)$ does not show magnetic ordering and is paramagnetic as the temperature is reduced to 2 K. Partial substitution of V with Co in $V[TCNE]_2{\cdot}z(CH_2Cl_2)$ introduces an addition disorder. While maintaining a T_c above room temperature and providing a means to chemically control the coercive field, the solution made powders did not show a PIM. Work is in progress to develop the means for deposition by CVD films of $V_xCo_{1-x}[TCNE]_2$.

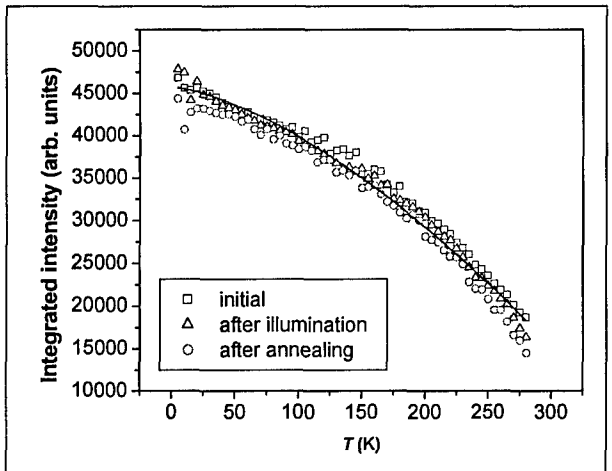

Fig. 5. Integrated EPR intensity before and after illumination of $V[TCNE]_2$ CVD film. Results show that the saturation magnetization remains unchanged.

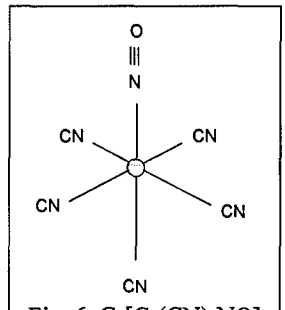

Fig. 6. $Cr[Cr(CN)_5NO]$

Recently we extended the classes of materials with PIM to

the pentacyano Prussian blue analogue $Cr[Cr(CN)_5NO]$, Fig. 6, with T_c = 80 K yields positive PIM present to ~ 50 K, Fig. 7. This illustrates that PIM is possible in a wide range of materials systems yielding many opportunities for optimization.

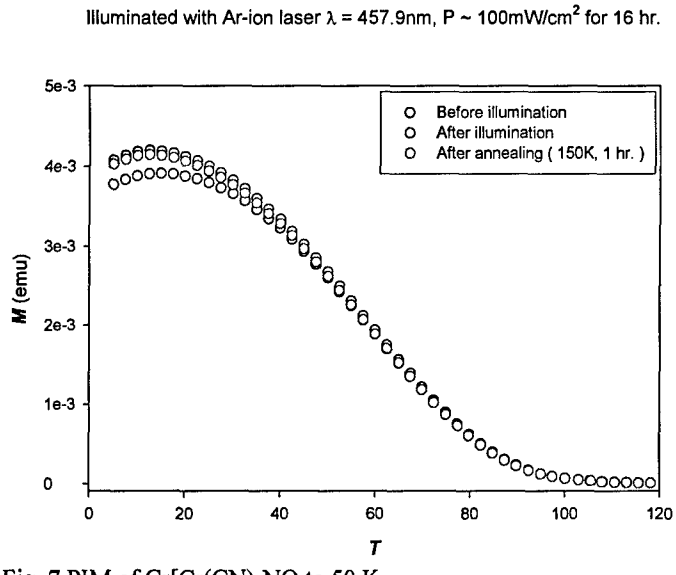

Fig. 7 PIM of $Cr[Cr(CN)_5NO$ to 50 K.

Figure 8 shows the magnetization vs. temperature for $V[TCNB]_x \cdot yCH_2Cl_2$ powders, illustrating that this is a new family of room temperature organic-based magnets (T_c = 325 K). We will be studying PIM of powders and modifying our techniques for CVD preparation of $V[TCNB]_x$ films. We also will develop techniques for mixed organic-based magnets, e.g., $V[TCNE]_x[TCNB]_{1-x}$. Organic acceptors tetracyanobenzene (TCNB) and tetracyanoethylene (TCNE) are illustrated in Fig. 9. Both TCNE and TCNB are spinless when neutral. They are both good acceptors and when having a minus 1 charge have the charge delocalized on the acceptor with associated spin one-half. Having a 'mixed' organic lattice

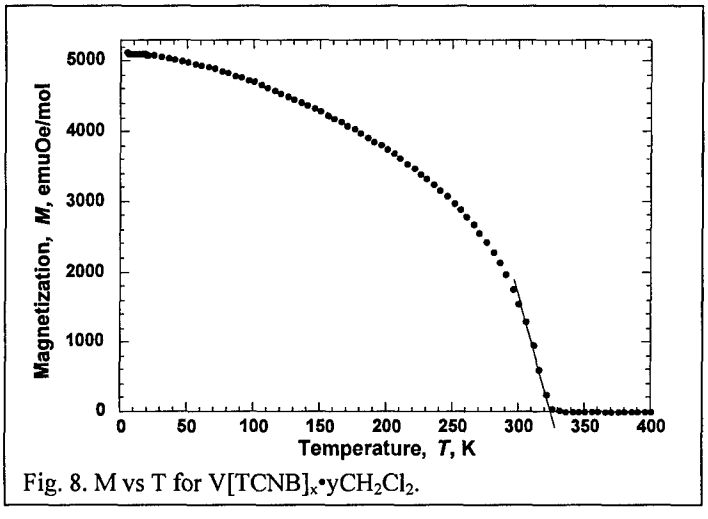

Fig. 8. M vs T for $V[TCNB]_x \cdot yCH_2Cl_2$.

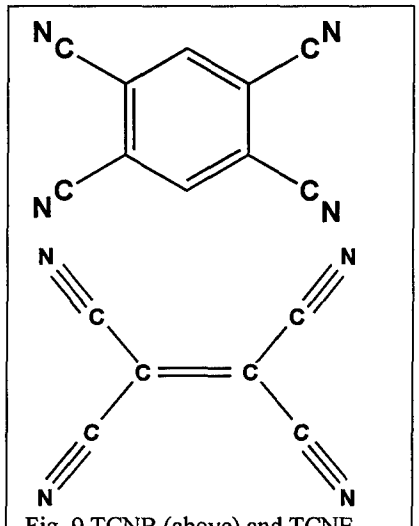
Fig. 9 TCNB (above) and TCNE (below).

$[TCNE]_x[TCNB]_{1-x}$ will lead to mismatch of their valence and conduction bands, resulting in higher electrical resistivity and therefore reduced eddy current losses. It is noted that mixed metals (e.g., Fe substituted for some of the V) also may be made to simultaneously control the coercive field and permeability as well as substitution of some of the TCNE by TCNB or analogs to control resistivity and loss.

Personnel Supported:

List professional personnel (Faculty, Post-Docs, Graduate Students, etc.) supported by and/or associated with the research effort.

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Presentations supported by AFOSR

Invited Talks presented at National and International Meetings:

A.J. Epstein, *New Physics and Phenomena: From Photoinduced Magnetism to Spintronic Materials,* **Meeting of the American Physical Society,** Austin, Texas, March 3-7, 2003.

A.J. Epstein, *Room Temperature Organic-based Magnetic Semiconductor* $V[TCNE]_2$, **Organic/Polymeric Spintronics Workshop**, Baltimore, MD, April 14-15, 2003.

A.J. Epstein, *Room Temperature Organic-based Magnetic Semiconductor* $V[TCNE]_2$ – *Opportunities for Spintronic Applications*, **Workshop on Fundamental Research Needs in Organic Electronic Materials**, Salt Lake City, UT, May 23-25, 2003.

A.J. Epstein, *New Developments in Magnetism from Organic Based Magnets,* **Alvin L. Kwiram Symposium on Optical, Electrical, and Magnetic Properties of Organic and Hybrid Materials,** Seattle, WA, June 23-25, 2003.

A.J. Epstein, *Organic-Based Magnets: From Low and High Temperature Magnets to Photoinduced Magnetism and Spintronics*, **Colloquium, Joint Institute of Chemical Physics,** Moscow, Russia, September 5, 2003.

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A.J. Epstein, *Organic-based Magnets Fractal Behavior, Photoinduced Magnetism, and Spintronics*, **International Conference on Quantum Transport in Synthetic Metals and Quantum Functional Semiconductors**, Seoul, Korea, November 20-22, 2003.

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A.J. Epstein, *Emerging Areas of Organic/Molecule-Based Magnetism*, **Workshop on Nanomagnetism Using X-Ray Techniques**, Fontana, Wisconsin, 29 August to 1 September 2004.

A.J. Epstein, *Organic-Based Magnetic and Nonmagnetic Semiconductors: New Approaches to Spintronics,* **9th International Conference on Molecule-based Magnets,** Tsukuba, Japan, October 4-8, 2004.

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A.J. Epstein, *Organic-based Spin Valve Devices,* **Seminar on Application of Molecular Spin: From Nanomagnets to Biological Spin Systems, University of Tokyo Research Center for Advanced Science and Technology,** Tokyo, Japan, October 8, 2004.

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A.J. Epstein, *Organic-Based Magnetic and Non-Magnetic Semiconductors for Spintronics*, **Sixth International Topical Conference on Optical Probes of Conjugated Polymers and Biosystems**, Bangalore, India, January 4-8, 2005.

A.J. Epstein, *Photoinduced Magnetism: Progress and New Opportunities*, **Second Annual DOE Solid State Lighting Workshop**, San Diego, California, February 3-4, 2005.

A.J. Epstein, *Organic-Based Magnetic and Non-Magnetic Semiconductors for Spintronics*, **Materials Research Society Spring Meeting,** San Francisco, CA, March 28-April 1, 2005.

A.J. Epstein, *Organic-Based Magnetic and Nonmagnetic Semiconductors for Spintronics*, **AFOSR Wide Band Gap Ferromagnetic Semiconductors Workshop**, Edinburgh, Scotland, May 15-19, 2005.

A.J. Epstein, *Unconventional Magnetic and Electronic Materials,* **Symposium on Unconventional Magnetic and Electronic Materials, Columbus, Ohio**, June 1-4, 2005.

A.J. Epstein, *Polymer Electronics and Photonics at OSU*, **Emerging Technology Forum**, Columbus, Ohio, July 12, 2005.

A.J. Epstein, *Photoinduced Magnetism In Molecule-Based Magnets*, **AFOSR Polymer Chemistry and Polymer Matrix Composites Program Reviews**, San Diego, California, August 8-13, 2005.

A.J. Epstein, *Organic-Based Magnets: New Functions for New Technologies,* **The International Chemical Congress of Pacific Basin Societies (Pacifichem 2005)**, Honolulu, Hawaii, December 15-20, 2005.

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A.J. Epstein, *Extraordinary Magnetotransport Phenomena in Organic Semiconductors,* **2nd International Workshop of NANO Systems Institute, Seoul National University,** Seoul, Korea, May 8, 2006.

A.J. Epstein, Keynote Lecture, *Organic-Based Magnets and Spintronics,* **The International Conference on Science and Technology of Synthetic Metals (ICSM) 2006,** Dublin, Ireland, July 2-7, 2006.

A.J. Epstein, V.N. Prigodin, F.-C. Hsu, J.D. Bergeson, D.M. Lincoln, and N.-R. Chiou, *Anomalous Electric and Magnetic Field and Nanoscale Morphology Control of Response in Electronic Polymers*, **World Polymer Congress – Macro 2006, 41st International Symposium on Macromolecules**, Rio de Janeiro, Brazil, July 16-21, 2006.

Contributed Talks Presented at National and International Meetings:

S.J. Etzkorn, W. Hibbs, J.S. Miller, and A.J. Epstein, *Magnetic Reversal and Relaxation in a Quasi-1D Fractal Cluster Glass,* **Meeting of the American Physical Society,** Austin, Texas, March 3-7, 2003 [Bulletin of the American Physical Society 48, 403 (2003)].

Y. Bataiev, N.P. Raju, T. Savrin, V.N. Prigodin, K.I. Pokhodnya, J.S. Miller, and A.J. Epstein, *Ferrimagnetic Resonance of High T_c Organic-Based Magnet V[TCNE]$_x$ Films,* **Meeting of**

the American Physical Society, Austin, Texas, March 3-7, 2003 [Bulletin of the American Physical Society 48, 1252 (2003)].

N.P. Raju, V.N. Prigodin, K.I. Pokhodnya, J.S. Miller, and A.J. Epstein, *High Field Positive Magnetoresistance in Organic-Based Magnetic Semiconductor V(TCNE)$_x$ films,* **Meeting of the American Physical Society,** Austin, Texas, March 3-7, 2003 [Bulletin of the American Physical Society 48, 1252 (2003)].

K.I. Pokhodnya, V. Burtman, J. Raebiger, A.J. Epstein, and J.S. Miller *Re-Entrant Behavior of Ferrimagnetic VxCo1-x[TCNE]$_2$ Organic-Based Magnets,* **Meeting of the American Physical Society,** Austin, Texas, March 3-7, 2003.

J.W. Yoo, D.A. Pejakovic, H. Tokoro, S.I. Ohkoshi, K. Hashimoto, and A.J. Epstein, *Magnetic Behavior and Photoinduced Demagnetization in Rubidium Manganese Hexacyanoferrate,* **Meeting of the American Physical Society,** Austin, Texas, March 3-7, 2003 [Bulletin of the American Physical Society 48, 1378 (2003)].

S.J. Etzkorn, W.C. Pirkle, J. Yang, L. Dai, and A.J. Epstein, *Spin Dependent Transport in Magnetic Multilayers with an Organic Spacer Layer,* **Meeting of the American Physical Society,** Montreal, Canada, March 22-26, 2004 [Bulletin of the American Physical Society 49, 486 (2004)].

Y. Bataiev, N.P. Raju, K.I. Pokhodnya, A.J. Epstein, and J.S. Miller, *Ferrimagnetic Resonance of VxCo1-x[TCNE]$_2$ Organic-Based Magnetic Semiconductors,* **Meeting of the American Physical Society,** Montreal, Canada, March 22-26, 2004 [Bulletin of the American Physical Society 49, 486 (2004)].

K.I. Pokhodnya, A.J. Epstein, and J.S. Miller, *Transport Properties of Molecule-Based V[TCNE]$_x$ Magnetic Films,* **Meeting of the American Physical Society,** Montreal, Canada, March 22-26, 2004 [Bulletin of the American Physical Society 49, 486 (2004)].

J.D. Bergeson, R. Shima Edelstein, L.M. Dai, and A.J. Epstein, *Spin-valves Incorporating Magnetic and Nonmagnetic Organic Semiconductors,* **The Ohio Nanotechnology Summit,** March 2-3, 2005, Dayton, Ohio.

J.H. Park and A.J. Epstein, *Photonic, Electronic, and Magnetic Polymers,* **The Ohio Nanotechnology Summit,** March 2-3, 2005, Dayton, Ohio.

J.W. Yoo, R. Shima Edelstein, P.I. Pokhodnya, A.J. Epstein, and J.S. Miller, *Photoinduced Magnetism in Chemical Vapor Deposited V(TCNE)$_x$, x ~ 2 films,* **Meeting of the American Physical Society,** Los Angeles, California, March 21-25, 2005 [Bulletin of the American Physical Society 50, 1433 (2005)].

R. Shima Edelstein, J.W. Yoo, N.P. Raju, J.D. Bergeson, K.I. Pokhodnya, J.S. Miller, and A.J. Epstein, *Organic-based Magnetic Thin Films by Low Temperature CVD,* **Materials Research Society Spring Meeting,** San Francisco, CA, March 28-April 1, 2005.

J.W. Yoo, R. Shima Edelstein, A.J. Epstein, K. Pokhodnya, and J.S. Miller, *Photoinduced Magnetic and Electronic Phenomena in Organic Magnetic Semiconductor $V(TCNE)_{x\sim2}$,* **Meeting of the American Physical Society**, Baltimore, Maryland, March 13-17, 2006 [Bulletin of the American Physical Society 51, 628 (2006)].

J. Kortright, R. Shima Edelstein, D.M. Lincoln, J.W. Yoo, and A.J. Epstein, *V, C, and N Soft X-Ray Absorption and MCD of Molecular Magnet $V(TCNE)_{x\sim2}$ Films,* **Meeting of the American Physical Society**, Baltimore, Maryland, March 13-17, 2006 [Bulletin of the American Physical Society 51, 1515 (2006)].

J.D. Bergeson, D.M. Lincoln, R. Shima Edelstein, V.N. Prigodin, and A.J. Epstein, *Anomalous Magnetoresistance Phenomena in Organic Semiconductors* , **Meeting of the American Physical Society**, Baltimore, Maryland, March 13-17, 2006 [Bulletin of the American Physical Society 51, 1525 (2006)].

R. Shima Edelstein, D. M. Lincoln, J.W. Yoo, N.P. Raju, J.D. Bergeson, and A.J. Epstein, *Preparation, Magnetism, and Applications of Thin Films of the Organic Semiconductor $V(TCNE)_{x\sim2}$,* **Meeting of the American Physical Society**, Baltimore, Maryland, March 13-17, 2006 [Bulletin of the American Physical Society 51, 1525 (2006)].

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Y. Bataiev, N.P. Raju, K.I. Pokhodnya, J.S. Miller, and A.J. Epstein, Nanoscale Control Of $V_xCo_{1-x}[TCNE]_2$ Organic-Based Magnetic Semiconductors, **The Ohio Nanotechnology Summit**, Columbus, Ohio, April 4-5, 2006.

Jeremy D. Bergeson, Derek M. Lincoln, Vladimir N. Prigodin, and Arthur J. Epstein, Anomalous Room Temperature Magnetoresistance in Thin-Film Organic Semiconductor Devices, **The Ohio Nanotechnology Summit**, Columbus, Ohio, April 4-5, 2006.

R. Shima Edelstein, D.M. Lincoln, Jung-Woo Yoo, N.P. Raju, J.D. Bergeson, J.B. Kortright, and A. J. Epstein, *Nanoscale Control of Preparation, Magnetism, and Applications of Thin Films of the Organic Semiconductor $V[TCNE]_{x\sim2}$,* **The Ohio Nanotechnology Summit**, Columbus, Ohio, April 4-5, 2006.

Seminars and Colloquia:

A.J. Epstein, *Organic-Based Magnets: From Discovery to Room Temperature Magnets, Photoinduced Magnetism and Spintronics*, **Colloquium, Ioffe Institute**, Saint Petersburg, Russia, September 9, 2003.

A.J. Epstein, *Organic-Based Magnets: From Discovery to Room Temperature Magnets, Photoinduced Magnetism and Spintronics*, **Colloquium, Industrial Technology Research Institute**, Hsinchu, Taiwan, November 4, 2003.

A.J. Epstein, *New Technologies for Microdevices*, **National Science Foundation-Integrative Graduate Education and Research Traineeship Program First Annual Symposium on Molecular Engineering of Microdevices,** The Ohio State University, Columbus, OH, December 10th, 2003.

A.J. Epstein, *Organic-Based Magnets,* **Society for Physics Students Seminar, Physics Department, The Ohio State University**, Columbus, Ohio, February 10, 2004.

A.J. Epstein, *Organic-Based Magnets: New Materials, New Phenomena, and New Applications,* **Colloquium, Physics Department, Case Western Reserve University,** Cleveland, Ohio, April 22, 2004.

A.J. Epstein, *Organic-Based Magnets: New Materials, New Phenomena, and New Applications,* **Colloquium, Institute of Applied Chemistry, Chinese Academy of Sciences,** Changchun, P.R. China, May 17, 2004.

A.J. Epstein, *Organic- and Polymer- Based Magnets: New Materials, New Phenomena, and New Applications*, **Conference for the Celebration of 50 Years of Polymer Science at Peking University,** Beijing, P.R. China, May 28, 2004.

A.J. Epstein, *Organic-Based Magnets: New Materials, New Phenomena, and New Applications,* **Colloquium, University of Maryland,** College Park, Maryland, November 2, 2004.

A.J. Epstein, *Progress in Organic Spintronics*, **Department of Chemistry, University of Utah**, Salt Lake City, Utah, July 20, 2005.

A.J. Epstein, *Metallic and Magnetic Polymers and Their Control by Electric and Magnetic Fields*, **Sandia National Laboratories**, Albuquerque, New Mexico, September 12, 2005.

A.J. Epstein, *Electronic and Magnetic Field Effects in Organic Materials*, **DuPont i Technologies**, Circleville, Ohio, September 22, 2005.

A.J. Epstein, *Strong Effects of Weak Magnetic Fields in Organic Semiconductors,* **Center for Electronic/Magnetic Nanoscale Composite Multifunctional Materials, The Ohio State University**, Columbus, Ohio, February 10, 2006.

A.J. Epstein, *Organic-Based Magnetic and Non-Magnetic Semiconductors for Spintronics,* **Oak Ridge National Laboratory,** Oak Ridge, Tennessee, February 20, 2006.

A.J. Epstein, *Organic-based Magnets: From 'Only Worth a Footnote' to Spintronics, Photoinduced Magnetism, and Beyond,* **Colloquium, City College of New York**, New York, New York, March 22, 2006.

A.J. Epstein, *Organic-Based Magnets and Spintronics,* **Colloquium, University of California at San Diego,** San Diego, California, May 4, 2006.